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An Inter-Regional Comparison of Animal Domestication in the Northern and Southern Levant*

▼ **Abstract** Based on the archaeozoological record for the northern and southern Levant compiled from more than 70 Neolithic sites, this study tracks the evolution of ungulate domestication in the region, from its initiation in the tenth millennium BC to the establishment of fully-fledged animal husbandry by the sixth millennium BC. We synthesize available data for both regions for the four main domesticates – sheep, goat, cattle and pig – highlighting inter-specific and inter-regional patterns in the domestication process. This is of special interest given the traditional divide in timing and the cultural-historical sequences between the north and south. Issues concerning methodologies used to assess domestic status, single versus multiple origins of domestic taxa, diffusion events, the chronology and the rate of the process are briefly discussed with reference to changes in the relative frequencies of ungulates in the archaeofaunal assemblages. Reference is also made to concurrent changes in biometry, morphology, sex and age profiles that have been documented in the archaeozoological record.

▼ **Keywords** Near East, Neolithic, PPNB interaction sphere, archaeozoology, herding, early livestock, sheep, goat, cattle, pig

▼ **Résumé** S'appuyant sur les données archéozoologiques de plus de 70 sites néolithiques du Levant Nord et Sud, cette étude retrace l'évolution de la domestication des ongulés au Proche-Orient, depuis ses origines au 10^e millénaire avant notre ère jusqu'à la pleine maîtrise de l'élevage au 6^e millénaire. Les données disponibles pour les quatre espèces domestiquées – mouton, chèvre, bœuf et porc – mettent en évidence des modalités interspécifiques et

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interrégionales du processus de domestication. Ceci présente un intérêt particulier étant donné les divergences connues dans les séquences chronoculturelles entre le nord et le sud. Les questions sur les approches utilisées, les hypothèses concernant l'origine unique ou multiple de leur domestication, la chronologie et les rythmes de diffusion du processus, sont brièvement discutées à partir des changements observés dans les fréquences relatives des ongulés. D'autres paramètres comme la biométrie, la morphologie, le sexe-ratio et les profils de mortalité sont pris en compte pour interpréter ces changements.

▼ **Mots clés** Proche-Orient, Néolithique, sphère d'interaction PPNB, archéozoologie, élevage, mouton, chèvre, bœuf, porc.

In a recent paper, Bar-On and collaborators highlighted the startling fact that currently human global biomass (calculated as ≈ 0.06 Gt C) is an order of magnitude higher than the mass of all existing wild mammals (≈ 0.007 Gt C), while the global biomass of livestock (dominated by cattle and pigs) is significantly higher than both (≈ 0.1 Gt C).¹ The same is true for birds, with domestic poultry (≈ 0.005 Gt C, dominated by chickens) having a global biomass that is three times higher than that of wild avian species (≈ 0.002 Gt C). Clearly factors, such as climate change and/or extinctions – caused by natural or anthropogenic actions – have contributed to this striking change in faunal biomass.² However, the most dramatic and long-term factor responsible for this shift was undoubtedly the onset of animal domestication *ca.* 12,000 years ago. Coinciding with the start of the Holocene, the inception of domestication (of plants and animals) is seen by some scholars³ as heralding the onset of the Anthropocene,⁴ the point in time when humans began to have the most significant and irreversible impact on the earth's environment. Given the magnitude and spectrum of changes associated with domestication, we concur with this view. Domestication marks a radical

1 Yinon M. BAR-ON, Rob PHILLIPS, Ron MILO, "The Biomass Distribution on Earth", *Proceedings of the National Academy of Sciences*, vol. 115, no. 25 (2018), pp. 6506-11.

2 Tobias ANDERMANN, Soren FAURBY, Samuel T. TURVEY et al., "The Past and Future Human Impact on Mammalian Diversity", *Science Advances*, vol. 6, no. 36 (2020), article eabb2313, <https://advances.sciencemag.org/content/6/36/eabb2313>; Anthony D. BARNOSKY, "Megafauna Biomass Tradeoff as a Driver of Quaternary and Future Extinctions", *Proceedings of the National Academy of Sciences*, vol. 105, no. suppl. 1 (2008), pp. 11543-48; Christopher E. DOUGHTY, Adam WOLF, Christopher B. FIELD, "Biophysical Feedbacks between the Pleistocene Megafauna Extinction and Climate: The First Human-Induced Global Warming?", *Geophysical Research Letters*, vol. 37, no. 15 (2010), <https://doi.org/10.1029/2010GL043985>; Paul L. KOCH, Anthony D. BARNOSKY, "Late Quaternary Extinctions: State of the Debate", *Annual Review of Ecology, Evolution, and Systematics*, vol. 37, no. 1 (2006), pp. 215-50.

3 See for example Bruce D. SMITH, Melinda A. ZEDER, "The Onset of the Anthropocene", *Anthropocene*, vol. 4 (2013), pp. 8-13.

4 This, despite the fact that many researchers consider the start of this epoch as either earlier or much later than the Neolithic; see Simon S. LEWIS, Mark MASLIN, "Defining the Anthropocene", *Nature*, vol. 519 (2015), pp. 171-80.

turning point, when human “niche construction” underwent a marked acceleration that changed our planet forever, heralding a new epoch in human history.

Given the long and extensive record of formal research on plant and animal domestication, beginning with Darwin’s publication *The Variation of Animals and Plants Under Domestication*,⁵ it is surprising how little consensus there is on very fundamental issues relating to this topic. It begins with the motivation that led modern humans in the Near East to abandon the hunting and gathering way of life they had followed for about 200,000 years, a topic that remains the focus of intense debate and for which multiple explanations have been offered such as a climate-driven shift, a need for increased food production due to increased population size, a need to increase fat intake and cultural competition.⁶ Likewise, it is unclear if one or multiple path(s) led to this transformation, while the mechanisms of how this was achieved are contentious and include a broad spectrum of hypotheses. For example, processes of animal domestication that have been proposed include pet keeping, an extension of intensive hunting strategies, pre-domestication, that is to say different forms of cultural management, commensalism, and the intentional selection of traits in a founder population *versus* the concept of unconscious selection, i.e. accidental changes concomitant upon incorporation in an anthropogenic environment.⁷ These issues continue to be debated. What is clear however, is that domestication of the “barnyard complex” was a unidirectional and gradual process and that in both its pace and make-up it followed markedly different trajectories within and between regions.⁸ Thus, despite the “revolutionary” outcome of this process, we feel that

5 Charles DARWIN, *The Variation of Animals and Plants under Domestication*, vol. 2 (Cambridge, 2010).

6 Andrew M. T. MOORE, Gordon C. HILLMAN, “The Pleistocene to Holocene Transition and Human Economy in Southwest Asia: The Impact of the Younger Dryas”, *American Antiquity*, vol. 57, no. 3 (1992), pp. 482-94; Mark Nathan COHEN, “Introduction: Rethinking the Origins of Agriculture”, *Current Anthropology*, vol. 50, no. 5 (2009), pp. 591-95; Brian HAYDEN, “The Proof Is in the Pudding: Feasting and the Origins of Domestication”, *Current Anthropology*, vol. 50, no. 5 (2009), pp. 597-601; Jean-Denis VIGNE, Daniel HELMER, “Was Milk a ‘Secondary Product’ in the Old World Neolithisation Process? Its Role in the Domestication of Cattle, Sheep and Goats”, *Anthropozoologica*, vol. 42, no. 2 (2007), pp. 9-40.

7 Among others: Liora K. HORWITZ, “A Reassessment of Caprovine Domestication in the Levantine Neolithic: Old Questions, New Answers”, in Israel HERSHKOVITZ (ed.), *People and Culture in Change: Proceedings of the Second Symposium on Upper Palaeolithic, Mesolithic, and Neolithic Populations of Europe and the Mediterranean Basin*, (Oxford, 1989), pp. 153-81; Daniel ZOHARY, Eitan TCHERNOV, Liora K. HORWITZ, “The Role of Unconscious Selection in the Domestication of Sheep and Goats”, *Journal of Zoology*, vol. 245, no. 2 (1998), pp. 129-35; Jean-Denis VIGNE, “The Origins of Animal Domestication and Husbandry: A Major Change in the History of Humanity and the Biosphere”, *Comptes Rendus Biologies*, vol. 334, no. 3 (2011), pp. 171-81; Melinda A. ZEDER, “The Domestication of Animals”, *Journal of Anthropological Research*, vol. 68, no. 2 (2012), pp. 161-90; Joris PETERS, Hijlke BUITENHUIS, Gisela GRUPE et al., “The Long and Winding Road: Ungulate Exploitation and Domestication in Early Neolithic Anatolia (10000-7000 Cal BC)”, in Sue COLLEDGE, Keith DOBNEY, Katie MANNING et al. (eds), *The Origins and Spread of Domestic Animals in Southwest Asia and Europe* (Walnut Creek, 2013), pp. 83-114; Mary C. STINER, Hijlke BUITENHUIS, Güneş DURU et al., “A Forager-Herder Trade-off, from Broad-Spectrum Hunting to Sheep Management at Aşıklı Höyük, Turkey”, *Proceedings of the National Academy of Sciences*, vol. 111, no. 23 (2014), pp. 8404-09.

8 For example, Benjamin S. ARBUCKLE, “Pace and Process in the Emergence of Animal Husbandry in Neolithic Southwest Asia”, *Bioarchaeology of the Near East*, vol. 8 (2014), pp. 53-81.

the term “Neolithic Revolution”⁹ – a common synonym for domestication – is inappropriate since it implies a single event of sudden change.

One point of consensus is that the earliest domestication of ungulates (and plants) took place in the Near East from around the tenth millennium BC onwards, within the geographically restricted area of overlap of their wild ancestors. However, the debate on whether this occurred in a single nexus *versus* multiple centres is still unclear for many species, attesting to the complexity of this issue.¹⁰ A second point of consensus is that from the Near East, a domestication package comprising flora and fauna dispersed out, via population migration and/or dissemination of this know-how (depending on the target region), and that this occurred gradually. Consequently, domestic herds raised and managed by a broad spectrum of human communities moved westward, traversing Europe from the seventh millennium BC onwards¹¹ and reached the northwestern Mediterranean by the early sixth millennium BC¹² and as far north as Britain and Sweden by mid and late fifth millennia BC, respectively.¹³ A similar progression is documented eastwards and southwards.¹⁴ However, there are still many gaps in our understanding of the patterning and processes involved in the dispersion of this transformative innovation.

This paper addresses the initial steps in animal domestication through a compendium of current data on the evolution of animal domestication for a heartland region within the Near East – the northern and southern Levant.

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- 9 Gordon V. CHILDE, *New Light on the Most Ancient East: The Oriental Prelude to European Prehistory* (London, 1935).
- 10 See discussion of this issue in Gregor LARSON, Keith DOBNEY, Umberto ALBARELLA et al., “Worldwide Phylogeography of Wild Boar Reveals Multiple Centers of Pig Domestication”, *Science*, vol. 307, no. 5715 (2005), pp. 1618-21; Dorian FULLER, George WILLCOX, Robin G. ALLABY, “Early agricultural pathways: moving outside the ‘core area’ hypothesis in Southwest Asia”, *Journal of Experimental Botany*, vol. 63, no. 2 (2012), pp. 617-33.
- 11 Melinda A. ZEDER, “Domestication and Early Agriculture in the Mediterranean Basin: Origins, Diffusion, and Impact”, *Proceedings of the National Academy of Sciences*, vol. 105 (2008), pp. 11597-604; James CONOLLY, Sue COLLEDGE, Keith DOBNEY et al., “Meta-Analysis of Zooarchaeological Data from SW Asia and SE Europe Provides Insight into the Origins and Spread of Animal Husbandry”, *Journal of Archaeological Science*, vol. 38, no. 3 (2011), pp. 538-45.
- 12 Didier BINDER, Janet BATTENTIER, Laurent BOUBY et al., “First Faming in the North-Western Mediterranean: Evidence from Castellar-Pendimoun during the Sixth Millennium BCE”, in Kurt J. GRON, Lasse SØRENSEN, Peter ROWLEY-CONWY (eds), *Farmers at the Frontier. A Pan-European Perspective on Neolithisation* (Oxford/Philadelphia, 2020), pp. 145-59.
- 13 Kurt J. GRON, Janet MONTGOMERY, Peter ROWLEY-CONWY, “Cattle Management for Dairying in Scandinavia’s Earliest Neolithic”, *Plos One*, vol. 10, no. 7 (2015), article e0131267, <https://doi.org/10.1371/journal.pone.0131267>; Vicki CUMMINGS, James MORRIS, “Neolithic Explanations Revisited: Modelling the Arrival and Spread of Domesticated Cattle into Neolithic Britain”, *Environmental Archaeology* (2018), <https://www.tandfonline.com/doi/full/10.1080/14614103.2018.1536498>.
- 14 For example, Seiji KADOWAKI, Keiko OHNISHI, Saiji ARAI et al., “Mitochondrial DNA Analysis of Ancient Domestic Goats in the Southern Caucasus: A Preliminary Result from Neolithic Settlements at Göytepe and Hacı Elamxanlı Tepe”, *International Journal of Osteoarchaeology*, vol. 27 (2016), pp. 245-60; William T.T. TAYLOR, Mélanie PRUVOST, Cosimo POSTH et al., “Evidence for Early Dispersal of Domestic Sheep into Central Asia”, *Nature Human Behaviour*, (2021), <https://doi.org/10.1038/s41562-021-01083-y>; Veerle LINSEELE, Wim VAN NEER, Sofie THYS et al., “New Archaeozoological Data from the Fayum ‘Neolithic’ with a Critical Assessment of the Evidence for Early Stock Keeping in Egypt”, *Plos One*, vol. 9, no. 10 (2014), article e108517, <https://doi.org/10.1371/journal.pone.0108517>.

Through comparison of these regions, we track its initiation in the tenth millennium BC through to the establishment of fully-fledged animal husbandry by the sixth millennium BC. It must be emphasized that the focus of this paper is to synthesize the existing corpus of information and not to undertake an in-depth critique. Although this may be perceived as a shortcoming, it is hoped that this integrated data review for the two regions will help to elucidate the core issues and so, foster future research and debate.

Background

Research area

This study compares available data between two regions, the northern Levant (NL) and the southern Levant (SL), in order to highlight the similarities and differences in the timing and nature of the domestication process. Figure 1 depicts most of the archaeological sites that provided enough faunal data for such a study. We define the NL as bordered on the west by the Mediterranean Sea and comprising Syria to the eastern edge of the Syrian Desert and the Khabur River as the northeastern limits, while the northern extent is the ~~western end of the Zagros and Taurus mountains~~ including the Upper Euphrates and the Upper Tigris. The SL is defined here as the territory encompassing Lebanon, the southern part of Syria, all of Jordan, the Palestine Autonomous Authority and Israel, with the Litani River and Damascus Basin demarcating its northern borders, and the Sinai Peninsula as its southernmost extent. For details on the physical geography of the Levant in general see Suriano.¹⁵ The large area covered by the Levant is characterized by diverse physical and phytogeographic environments. It is a transitional zone between the temperate Mediterranean domain and the subtropical deserts comprising Irano-Turanian vegetation zones trending to a more arid Saharo-Sindian biome on its southern and eastern flanks.¹⁶ Overall, the NL is wetter than the SL. The NL region encompasses the Euphrates and Tigris river systems, while the river systems of the SL are the Jordan River and its tributaries. These geographic and environmental features have undoubtedly influenced species distribution and richness, although, as discussed below, at the onset of the tenth millennium BC, the wild ungulate progenitors of domestic ~~stock~~ (mouflon *Ovis orientalis*, bezoar goat *Capra aegagrus*, boar *Sus scrofa fer.*, aurochs *Bos primigenius*), inhabited both regions.

¹⁵ Matthew J. SURIANO, "Historical Geography of the Ancient Levant", in Ann E. KILLEBREW, Margret L. STEINER (eds), *The Oxford Handbook of the Archaeology of the Levant: c. 8000-332 BCE* (Oxford, 2014), pp. 9-23.

¹⁶ Alexander RUDOV, Marjan MASHKOUR, Morteza DJAMALI et al., "A Review of C4 Plants in Southwest Asia: An Ecological, Geographical and Taxonomical Analysis of a Region with High Diversity of C4 Eudicots", *Frontiers in Plant Science*, vol. 11 (2020), <https://doi.org/10.3389/fpls.2020.546518>.

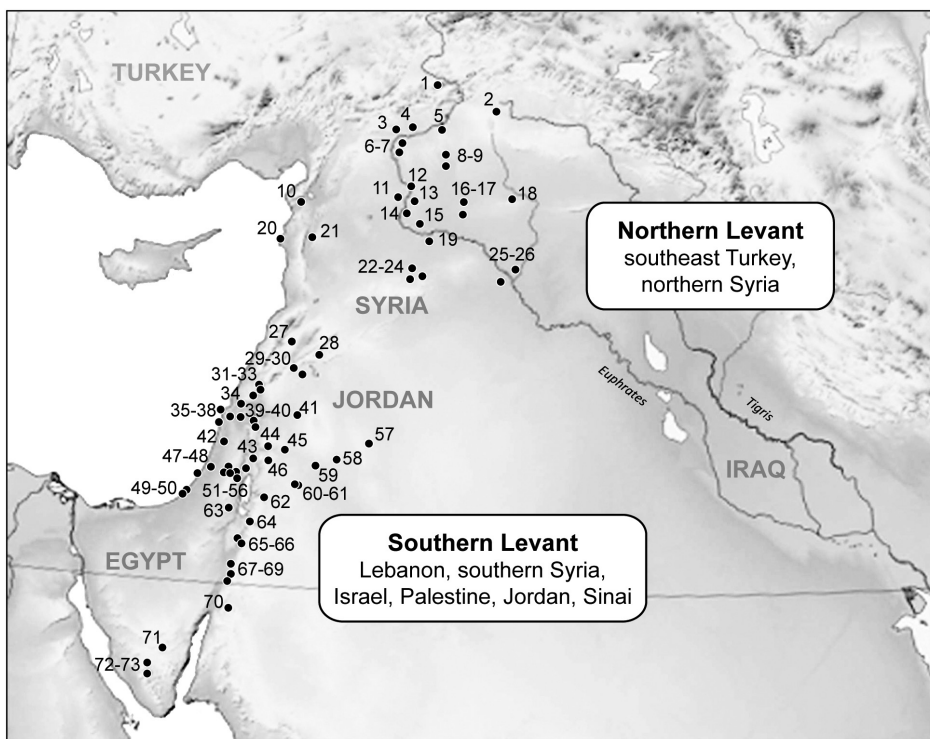


Figure 1. Map of the main archaeological sites that provided faunal data used in this study. 1: Cafer Höyük; 2: Çayönü; 3: Gritille; 4: Hayaz; 5: Nevalı Çori; 6: Mezraa-Teleilat; 7: Akarçay; 8: Göbekli Tepe; 9: Gürcütepe; 10: Tell Aray 2; 11: Tell Halula; 12: Dja'de el Mughara; 13: Jerf el Ahmar; 14: Cheikh Hassan; 15: Tell Mureybet; 16: Sabi Abyad; 17: Tell Assouad; 18: Tell Seker al Aheimar; 19: Abu Hureyra; 20: Ras Shamra; 21: Tell 'Ain el Kerkh; 22: Qdeir 1; 23: El Kowm 2; 24: Umm el Tlel; 25: Tell es-Sinn; 26: Bouqras; 27: Nachcharini; 28: Ghoraife; 29: Tell Ramad; 30: Tell Aswad; 31: Hagoshrim; 32: Tel Te'o; 33: Beisamoun; 34: Yiftah'el; 35: Atlit Yam; 36: Newe Yam; 37: Nahal Oren; 38: Kfar Hahores; 39: Munhatta; 40: Tel 'Eli; 41: Qarassa; 42: Tzur Nathan; 43: Wadi Shu'eib; 44: Iraq ed Dubb; 45: Kharaysin; 46: 'Ain Ghazal; 47: Ashqelon; 48: Hatoula; 49: Qatef Y2; 50: Ziqim; 51: El Khiam; 52: Jericho; 53: Abu Ghosh; 54: Motza; 55: Gilgal; 56: Qumran Cave 24; 57: Burqu' 27-2; 58: Dhuweila; 59: Azraq 31; 60: Wadi Jilat 7; 61: Wadi Jilat 13; 62: es-Sifiya; 63: Nahal Hemar; 64: Khirbet Hammam; 65: Wadi Fidan A; 66: Wadi Fidan C; 67: Beidha; 68: Ba'ja; 69: Basta; 70: Ayn Abu Nukhayla; 71: Abu Madi III; 72: Ujrat el-Mehed; 73: Wadi Tbeik.

Table 1. Chronological sequence of the Neolithic in northern and southern Levant (based on Borrell et al. 2015). Dates are written as cal. BCE.

Periods	Northern Levant	Southern Levant
PPNA	c. 10200–8800	c. 9600–8500
Early PPNB	c. 8800–8200	c. 8500–8100
Middle PPNB	c. 8200–7600	c. 8100–7500
Late PPNB	c. 7600–6900	c. 7500–6800
Final PPNB/PPNC	c. 6900–6400	c. 6800–6400
Early Pottery Neolithic	c. 6900–6100	c. 6400–5600

Approach

We base our work on the extensive record of archaeozoological publications for Neolithic sites from the Levant.¹⁷ The data base comprises well-dated sites for which relevant data is available on the status of the quartet of ungulates first targeted for domestication.¹⁸ While the sites are dispersed unevenly – both temporally and spatially within this landscape – taken together they span the entire Neolithic period and also provide some indication of geographic variation. It should be noted that there is a slight time lag between the two regions when we use the traditional chrono-cultural horizons i.e. Pre-Pottery Neolithic A (PPNA), Pre-Pottery Neolithic B (PPNB) divided into phases – Early (EPPNB), Middle (MPPNB), Late (LPPNB), and Terminal PPNB also termed Pre-Pottery Neolithic C (PPNC) (Table 1).¹⁹ This offset in timing is only a few centuries in most cases but can be significant when we consider the rhythms of the domestication process.

Like hunters stalking their prey, archaeozoologists working on the Neolithic in the Near East face the challenge of tracking the “footprints” of the first domestic ungulates (goats, *Capra hircus*; sheep, *Ovis aries*; cattle, *Bos taurus*; pigs, *Sus scrofa dom.*) using various clues in order to better understand how and when communities first integrated this new type of human-animal relationship into their way of life. Domestication is perceived as a two-way process of mutual benefit to both humans and animals.²⁰ In human societies, far reaching culturally mediated changes are visible following the incorporation of domestic animals into their economy, such as shifts in lifestyle, architecture, technology, symbolism, etc.²¹ The primary role played by people in the course of domestication was emphasized early on by Ducos and reiterated by Clutton-Brock,²² who both viewed domestication as foremost a cultural process in which animals were integrated into the social fabric of human communities and were perceived not

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- 17 We have excluded data from Neolithic sites in Cyprus (e.g., Klimonas, Shillourokambos, Khirokitia) because it is an insular context where domestic ungulates are not endemic.
 - 18 It is assumed that the quartet were selected for their ‘preadapted’ qualities that made them suitable for husbandry; see p. 157 in Liora K. HORWITZ, “A Reassessment of Caprovine Domestication ...”; Jean-Denis VIGNE, “The Origins of Animal Domestication and Husbandry ...”.
 - 19 Ferran BORRELL, Aripekka JUNNO, Joan Antón BARCELÓ, “Synchronous Environmental and Cultural Change in the Emergence of Agricultural Economies 10,000 Years Ago in the Levant”, *Plos One*, vol. 10, no. 8 (2015), article e0134810, <https://doi.org/10.1371/journal.pone.0134810>, fig. 1.
 - 20 Melinda A. ZEDER, “Pathways to Animal Domestication”, in Ardeshir B. DAMANIA, Calvin O. QUALSET, Patrick E. MCGUIRE et al. (eds) *Biodiversity in Agriculture: Domestication, Evolution, and Sustainability* (Cambridge, 2012), pp. 227-59.
 - 21 Ian KUIJT, Nigel A. GORING-MORRIS, “Foraging, Farming, and Social Complexity in the Pre-Pottery Neolithic of the Southern Levant: A Review and Synthesis”, *Journal of World Prehistory*, vol. 16, no. 4 (2002), pp. 361-440; Ferran BORRELL, Aripekka JUNNO, Joan Antón BARCELÓ, “Synchronous Environmental and Cultural Change ...”; Marcin BIAŁOWARCZUK, “From Circle to Rectangle. Evolution of the Architectural Plan in the Early Neolithic in the Near East”, *Polish Archaeology in the Mediterranean*, vol. 25 (2016), pp. 575-93.
 - 22 Pierre DUCOS, “Defining domestication: a clarification”, in Juliet CLUTTON-BROCK (ed.), *The Walking Larder: Patterns of Domestication, Pastoralism, and Predation* (London, 1989), pp. 28-30; Juliet CLUTTON-BROCK, “The process of domestication”, *Mammal Review*, vol. 22, no. 2 (1992), pp. 79-85.

only as sources of food and products, but also as objects of property, status and wealth. As for benefitting animals, domestication offered protection and access to reliable sources of nourishment. But it was accompanied by significant – and often non-reversible – modifications to their behaviour and phenotype (the latter expressed as a skeletal transformation), collectively termed “the domestication syndrome”,²³ and ultimately, alterations to their genotype. Currently, the most salient features that enable archaeozoologists to identify domestication in animals are phenotypic: (i) a reduction in body size and mass, including brain size, and (ii) morphological modifications such as to the shape and form of horns as well as cranial and limb proportions.²⁴ Since early domestic animals closely resemble their wild progenitors, especially in the early stages of domestication, precise identification of these changes are critical. In recent years, geometric morphometrics performed on different skeletal elements, can facilitate distinction between wild and domestic forms based on subtle shape differences²⁵ while, with the advance of techniques using aDNA and proteomics, genetic profiling of ancient animals is a complementary method.²⁶

A further diagnostic trait of domestication relates to age and sex profiles that were altered due to human intervention. Based on sex identification of both unfused and fused bones of modern wild goats, Zeder and Hesse were able to attribute sex to those from the Neolithic site of Ganj Dareh in Iran.²⁷ Based on their results they proposed that in these early domesticates, management entailing selective culling of surplus young males took place, but that these animals show no reduction in overall size. Diminution in body size was only a later occurrence. Notably, Zeder and Hesse state that “Uncertainty over the pace and causal connection between body size reduction and human control limits the utility of this marker”.²⁸ This concept has led to the idea that the initial transition from

23 This term was originally coined for domestic plants by Karl HAMMER, “Das Domestikationssyndrom”, *Die Kulturpflanze*, vol. 32 (1984), pp. 11–34.

24 Frederick Everard ZEUNER, *A History of Domesticated Animals* (London, 1963); Hans-Peter UERPMANN, *Probleme der Neolithisierung des Mittelmeerraums* (Wiesbaden, 1979); Richard H. MEADOW, “Osteological Evidence for the Process of Animal Domestication”, in Juliet CLUTTON-BROCK (ed.), *The Walking Larder: Patterns of Domestication, Pastoralism, and Predation* (London, 1989), pp. 80–90; Achilles GAUTIER, *La domestication : et l’Homme créa ses animaux* (Paris, 1990); Helmut HEMMER, *Domestication: The Decline of Environmental Appreciation* (2nd ed., Cambridge/New York, 1990); Wolf HERRE, Manfred RÖHRS, *Haustiere – Zoologisch Gesehen* (2nd ed., Berlin, 1990); Daniel HELMER, *La domestication des animaux par les Hommes préhistoriques* (Paris, 1992).

25 Max D. PRICE, Allowen EVIN, “Long-Term Morphological Changes and Evolving Human-Pig Relations in the Northern Fertile Crescent from 11,000 to 2000 cal. BC”, *Archaeological and Anthropological Science*, vol. 11 (2019), pp. 237–51; Allowen EVIN, Thomas CUCCHI, Andrea CARDINI et al., “The Long and Winding Road: Identifying Pig Domestication through Molar Size and Shape”, *Journal of Archaeological Science*, vol. 40, no. 1 (2013), pp. 735–43.

26 For example, Laurent A. F. FRANTZ, Daniel G. BRADLEY, Greger LARSON et al., “Animal Domestication in the Era of Ancient Genomics”, *Nature Reviews Genetics*, vol. 21, no. 8 (2020), pp. 449–60; Greger LARSON, Dorian Q. FULLER, “The Evolution of Animal Domestication”, *Annual Review of Ecology, Evolution, and Systematics*, vol. 66 (2014), pp. 115–36.

27 Melinda A. ZEDER, Brian HESSE, “The Initial Domestication of Goats (*Capra hircus*) in the Zagros Mountains 10,000 Years Ago”, *Science*, vol. 287, no. 5461 (2000), pp. 2254–57.

28 Melinda A. ZEDER, Brian HESSE, “The Initial Domestication ...”, p. 254.

hunting to herding was first marked by a shift in the age and sex profiles of animals, while the spectrum of phenotypic changes detailed above, only appeared later, perhaps obscured by so called *counter-domestication* processes, such as continued inter-breeding between wild animals and early domesticates²⁹ or discontinuity in management practices. The sex-age harvest model was developed for goats, but is now commonly accepted by researchers for all ungulates, despite the fact that some hunting profiles may mimic those of herding.³⁰

An important additional criterion for identification of domestication is the presence of a species outside of its natural biogeographic range. Likewise, a significant and diachronic increase in the frequency of a species within a region, can be indicative of taxon targeting.³¹ Supplementary criteria, that we will not relate to in this paper due to lack of space, are stable isotope values that can attest to changing lifestyle in ungulates following domestication, such as foddering³² or season of birth,³³ while the presence and severity of pathologies, such as skeletal deformations or those typical of infections that are common in livestock today, reflect changing living conditions (reduced mobility, crowding, nutritional deficiencies, etc).³⁴ Other features used in determining domestication are evidence for penning structures and dung deposits.³⁵

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- 29 Fiona B. MARSHALL, Keith DOBNEY, Tim DENHAM et al., “Evaluating the roles of directed breeding and gene flow in animal domestication”, *Proceedings of the National Academy of Sciences*, vol. 111 (2014), pp. 6153-58.
- 30 For example, Peter ROWLEY-CONWY, Umberto ALBARELLA, Keith DOBNEY, “Distinguishing Wild Boar from Domestic Pigs in Prehistory: A Review of Approaches and Recent Results”, *Journal of World Prehistory*, vol. 25, no. 1 (2012), pp. 1-44.
- 31 Frederick ZEUNER, *A History of Domesticated Animals* (London, 1963); Richard MEADOW, “Osteological Evidence for the Process of Animal Domestication ...”; Liora K. HORWITZ, “A Reassessment of Caprovine Domestication in the Levantine Neolithic ...”; Louise MARTIN, Yvonne EDWARDS, “Diverse Strategies: Evaluating the Appearance and Spread of Domestic Caprines in the Southern Levant”, in Sue COLLEDGE, Keith DOBNEY, Katie MANNING et al. (eds), *The Origins and Spread ...*, pp. 49-82.
- 32 For example, Gisela GRÜPE, Joris PETERS, “Climatic Conditions, Hunting Activities and Husbandry Practices in the Course of the Neolithic Transition: The Story Told by Stable Isotope Analyses of Human and Animal Skeletal Remains”, in Ron PINHASI, Jay STOCK (eds), *Human Bioarchaeology of the Transition to Agriculture* (Chichester, 2011), pp. 63-85; Cheryl MAKAREWICZ, Noreen TUROSS, “Finding Fodder and Tracking Transhumance: Isotopic Detection of Goat Domestication Processes in the Near East”, *Current Anthropology*, vol. 53, no. 4 (2012), pp. 495-505; Cheryl MAKAREWICZ, Liora K. HORWITZ, A. Nigel GORING-MORRIS, “Local adoption of animal husbandry in the southern Levant: An isotopic perspective from the Pre-Pottery Neolithic B funerary site of Kfar HaHoresh”, *Environmental Archaeology*, vol. 21 (2016), pp. 199-213.
- 33 Carlos TORNERO, Marie BALASSE, Miquel MOLIST et al., “Seasonal Reproductive Patterns of Early Domestic Sheep at Tell Halula (PPNB, Middle Euphrates Valley): Evidence from Sequential Oxygen Isotope Analyses of Tooth Enamel”, *Journal of Archaeological Science: Reports*, vol. 6 (2016), pp. 810-18.
- 34 John Rendle BAKER, Reginald BROTHWELL, *Animal Diseases in Archaeology* (London, 1980); Guillaume FOURNIÉ, Dirk U. PFEIFFER, Robin BENDREY, “Early Animal Farming and Zoonotic Disease Dynamics: Modelling Brucellosis Transmission in Neolithic Goat Populations”, *Royal Society Open Science*, vol. 4, no. 2 (2017), article 160943, <https://doi.org/10.1098/rsos.160943>.
- 35 Jacques-Élie BROCHIER, “Cayönü Tepesi. Domestication, Rythmes et Environnement au PPNB”, *Paléorient*, vol. 19, no. 2 (1993), pp. 39-49; Jordan T. ABELL, Jay QUADE, Güneş DURU et al., “Urine Salts Elucidate Early Neolithic Animal Management at Aşıklı Höyük, Turkey”, *Science Advances*, vol. 5, no. 4 (2019), article eaaw0038, <https://advances.sciencemag.org/content/5/4/eaaw0038>.

For this study, we have chosen to focus on changes in the relative abundance of the four main herd animals exploited over time in the continental Levant, in order to detect the major shifts in subsistence patterns and possibly the trade-off between hunting and herding practices. Differences in skills between specialists in identifying faunal remains and the state of conservation and fragmentation of bones are the main biases that weaken general comparisons. However, the data chosen here, generally expressed in NISP counts (number of identified specimens), offers the advantage of being easily available in the archaeozoological literature. As discrimination between wild and domestic is a matter of selective approaches and often personal interpretation, for calculating the frequencies we consider only taxa at the genus level without distinction of species or status (e.g., *Bos* for *B. primigenius* and/or *B. taurus*). Where relevant, we note some of the phenotypic landmarks (morphology or size) or information relating to age and sex culling, that have been applied by specialists to determine the domestic status of targeted taxa as their frequencies in the archaeozoological record changes.

Change in species representation

Gazelle: Gazelles, primarily the mountain gazelle (*Gazella gazella*) and the goitered gazelle (*Gazella subgutturosa*) were the major ungulates exploited in all the Levant from the Late Pleistocene to the Early Holocene and were never domesticated.³⁶ As illustrated in figure 2, for both the NL and the SL, gazelle frequencies composed up to 90% of the ungulate remains in the SL, and generally between 30 and 70% in the NL. A progressive shift in their representation is observed from the PPNA to the EPPNB, with a very marked decrease in their frequency during the MPPNB in both regions (reduced to less than 20% in most sites). A marked reduction in hunting intensity affected wild equids, another taxon that was intensively hunted in the NL,³⁷ while in the SL the same trend affected cervids and aurochs whose frequencies diminish steadily over time.³⁸ Wild caprine progenitors – the mouflon and bezoar goat – as well as ibex (*Capra nubiana*, which was never domesticated), were hunted in both regions during the Epipaleolithic and PPNA, with mouflon and ibex occurring primarily in sites

36 Louise MARTIN, “Gazelle (*Gazella* spp.) behavioural ecology: predicting animal behaviour for prehistoric environments in south-west Asia”, *Journal of Zoology*, vol. 250, no. 1 (2006), pp. 13-30.

37 Lionel GOURICHON, “Faune et saisonnalité. L’organisation temporelle des activités de subsistance dans l’Épipaléolithique et le Néolithique précéramique du Levant Nord (Syrie)”, *thèse de doctorat* (University Lumière-Lyon 2, 2004), <https://tel.archives-ouvertes.fr/tel-00721868/document> (latest access March 3, 2021).

38 Also Simon J. M. DAVIS, “Climatic Change and the Advent of Domestication: The Succession of Ruminant Artiodactyls in the Late Pleistocene-Holocene in the Israel Region”, *Paléorient*, vol. 8, n°2 (1982), pp. 5-15; Natalie D. MUNRO, Guy BAR-OZ, Jacqueline S. MEIER et al., “The Emergence of Animal Management in the Southern Levant”, *Scientific Reports*, vol. 8 (2018), p. 9279.

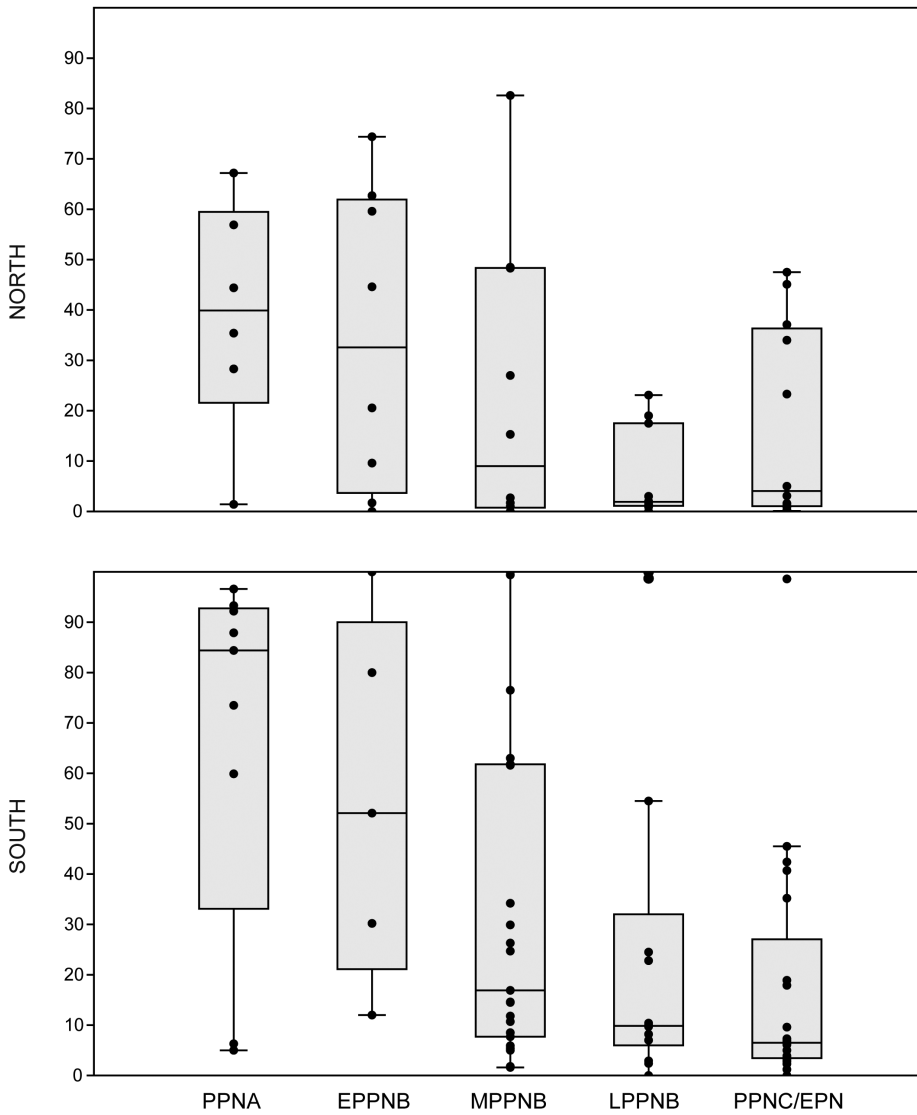


Figure 2. Relative frequencies of gazelles (*Gazella*) in the Neolithic sites of northern and southern Levant (based on the NISP of ungulate species).

in the desert margins,³⁹ or in high altitude sites like Nachcharini.⁴⁰ However, during the PPNB the tradition of hunting did not completely disappear in the Levant. For example, gazelle hunting continued in the Syrian desert,⁴¹ the Eastern Jordanian desert⁴² and was predominant even at some MPPNB sites in the SL Mediterranean hills, such as Kfar Hahoresh and Yiftah'el.⁴³ Overall though, a gradual reduction in species richness is evident throughout the PPNB-PPNC which specifically affected hunted mammals, so that they comprised a negligible component in most sites by the sixth millennium BC.⁴⁴

Caprines: In figure 3 we present the data for caprines, with sheep (*Ovis*) and goat (*Capra*) numbers pooled, since the distinction between these species for the majority of remains in a bone assemblage is not always possible. There is clearly a significant increase in caprines over time, with some variation between NL and SL for the PPNA/EPPNB periods, which, as noted by Arbuckle,⁴⁵ is probably the outcome of local hunting traditions as well as environmental conditions that have influenced which taxa were incorporated into the local

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- 39 For example, Howard HECKER, "Domestication revisited: its implications for faunal analysis", *Journal of Field Archaeology*, vol. 9 (1982), pp. 217-36; Simon DAVIS, Nigel GORING-MORRIS, Avi GOPHER, "Sheep Bones from the Negev Epipalaeolithic", *Paléorient*, vol. 8, no. 1 (1982), pp. 87-93; Pierre DUCOS, "A Re-Evaluation of the Fauna from the Neolithic Levels of El-Khiam", *Journal of the Israel Prehistoric Society*, vol. 27 (1997), pp. 75-81; Lisa YEOMANS, Louise MARTIN, Tobias RICHTER, "Expansion of the Known Distribution of Asiatic Mouflon (*Ovis orientalis*) in the Late Pleistocene of the Southern Levant", *Royal Society Open Science*, vol. 4, no. 8 (2017), article 170409, <https://doi.org/10.1098/rsos.170409>; Cheryl MAKAREWICZ, "Bridgehead to the *Badia*: New Biometrical and Isotopic Perspectives on Early Neolithic Caprine Exploitation Systems at 'Ain Ghazal", in Bill FINLAYSON, Cheryl MAKAREWICZ (eds), *Settlement, Survey and Stone. Essays on Near Eastern Prehistory in Honour of Gary Rollefson* (Berlin, 2014), pp. 117-31.
- 40 Stephen RHODES, Edward B. BANNING, Michael CHAZAN, "Mugharat An-Nachcharini: A Specialized Sheep-Hunting Camp Reveals High-Altitude Habitats in the Earliest Neolithic of the Central Levant", *Plos One*, vol. 15, no. 1 (2020), article e0227276, <https://doi.org/10.1371/journal.pone.0227276>.
- 41 Daniel HELMER, "Étude de la faune mammalienne d'El Kowm 2 (Syrie)", in Danielle STORDEUR (ed.), *El Kowm 2. Une île dans le désert. La fin du Néolithique précéramique dans la steppe syrienne* (Paris, 2000), pp. 233-64; Lionel GOURICHON, "Faune et Saisonnalité ...".
- 42 Louise MARTIN, Yvonne EDWARDS, "Diverse Strategies: Evaluating the Appearance ...".
- 43 A. Nigel GORING-MORRIS, Yuval GOREN, Liora K. HORWITZ et al., "The 1992 Season of Excavations at the Pre-Pottery Neolithic B Settlement of Kfar Hahoresh", *Journal of the Israel Prehistoric Society*, vol. 26 (1994), pp. 74-121; Liora K. HORWITZ, "Temporal and Spatial Variation in Neolithic Caprine Exploitation Strategies: a Case Study of Fauna from the Site of Yiftah'el (Israel)", *Paléorient*, vol. 29, no. 1 (2003), pp. 19-58; Jacqueline S. MEIER, A. Nigel GORING-MORRIS, Natalie D. MUNRO, "Provisioning the Ritual Neolithic Site of Kfar HaHoresh, Israel at the Dawn of Animal Management", *Plos One*, vol. 11, no. 11 (2016), article e0166573, <https://doi.org/10.1371/journal.pone.0166573>; Lidar SAPIR-HEN, Tamar DAYAN, Hamoudi KHALAILY et al., "Human Hunting and Nascent Animal Management at Middle Pre-Pottery Neolithic Yiftah'el, Israel", *Plos One*, vol. 11, no. 7 (2016), article e0156964, <https://doi.org/10.1371/journal.pone.0156964>.
- 44 For example, Liora K. HORWITZ, "The Impact of Animal Domestication on Species Richness: A Pilot Study from the Neolithic of the Southern Levant", *Archeozoologia*, vol. 8, no.1-2 (1996), pp. 53-70; Ilse KÖHLER-ROLLEFSON, Leslie A. QUINTERO, Gary O. ROLLEFSON, "A Brief note on the fauna from Neolithic 'Ain Ghazal", *Paléorient*, vol. 19, no. 2 (1993), pp. 95-97; Nimrod MAROM and Guy BAR-OZ, "The Prey Pathway: A Regional History of Cattle (*Bos taurus*) and Pig (*Sus scrofa*) Domestication in the Northern Jordan Valley, Israel", *Plos One*, vol. 8, no. 2 (2013), pp. 1-13.
- 45 Benjamin S. ARBUCKLE, "Pace and Process in the Emergence of Animal Husbandry ...".

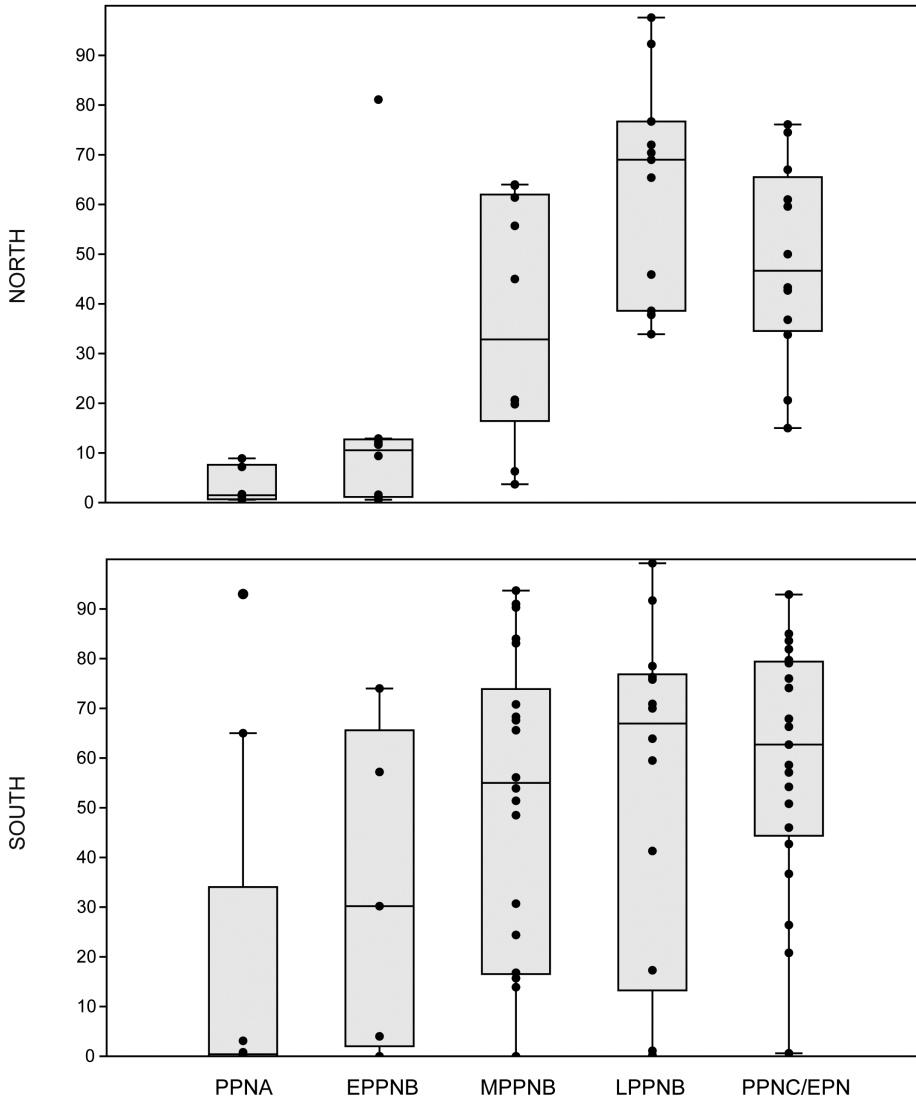


Figure 3. Relative frequencies of caprines (*Ovis* and/or *Capra*) in the Neolithic sites of northern and southern Levant (based on the NISP of ungulate species).

domestic economies. In the NL settlements located in steppe areas – where mainly *Ovis* are represented – caprine frequencies are generally low until the MPPNB. *Capra* in the NL are rare to absent except in the foothills of the Taurus Mountains, as at the site of Cafer Höyük. In the SL, wild sheep continued to be hunted into the LPPNB at sites like Basta that is located at the interface of steppe and arid zones.⁴⁶ In the few SL sites dated to the EPPNB located in the

⁴⁶ Cornelia BECKER, “Identification of Sheep and Goats: The Evidence from Basta”, in Hans Jörg NISSEN, Mujahed MUHESEN, Hans Georg K. GEBEL (eds), *Basta I: The Human Ecology* (Berlin, 2004),

northeastern part of this area, such as Qarassa and Kharaysin,⁴⁷ assemblages are dominated by goats of the same morphology and size as *C. aegagrus*. Likewise, in the EPPNB site of Motza located in the Mediterranean zone, large-sized *C. aegagrus*-type goats are quite common (20.7%) and show no phenotypic features of goat management.⁴⁸

For *Capra*, a reduction in their size is hardly perceptible in most sites before the LPPNB. However, at EPPNB Cafer Höyük (NL) and Tell Aswad in the Damascus Basin (SL), despite strong sexual dimorphism in this species, metric data show three size groups (with a predominance of large *aegagrus*-type animals), suggesting the presence of mixed populations of both domestic and wild goats.⁴⁹ Changes in the mortality patterns are evidenced in the EPPNB levels of Nevalı Çori, with young and subadults goats predominantly slaughtered, in contrast to the age profile observed in the PPNA at Göbekli Tepe.⁵⁰ In the NL, the discovery of dung remains at Tell Qarassa (and at Tell Aswad in the SL) in levels dated to the late EPPNB/early MPPNB, implies the stabling of ungulates, likely caprines.⁵¹ At this time, there is also evidence for morphometric changes coupled with selective culling at sites located in the northernmost extent of the SL (Ghoraife and Tell Aswad),⁵² denoting the earliest appearance of domestic goats in this region.

In both the NL and SL, the major shift in caprine frequencies occurs in the MPPNB with the greatest number of sites yielding more than 40-50% of caprines, predominantly goats (fig. 3). It should be noted that in MPPNB and even some LPPNB sites in the arid zones of the Levant (~~Nahal Divshon D1, Nahal Issaron~~), as well as southern Sinai (Ujrat el-Mehed, Wadi Tbeik), the ibex, a hunted element, ~~continues to predominate and composes generally~~ more

pp. 219-78.

47 Daniel HELMER, Lionel GOURICHON, "Premières données sur les modalités de subsistance à Tell Aswad (Syrie, PPNB Moyen et Récent, Néolithique Céramique Ancien) – Fouilles 2001-2005", in Emmanuelle VILA, Lionel GOURICHON, Alice M. CHOYKE et al. (eds), *Archaeozoology of the Southwest Asia and Adjacent Areas VIII* (Lyon, 2008), pp. 119-51; Daniel HELMER, Lionel GOURICHON, "The Fauna of Tell Aswad (Damascus, Syria), Early Neolithic Levels. Comparison with Northern and Southern Levant Sites", in Marjan MASHKOUR, Mark BEECH (eds), *Archaeozoology of the Near East 9. In Honour of Hans-Peter Uerpmann and François Poplin*, vol. 1 (Oxford, 2017), pp. 23-40.

48 Natalie D. MUNRO, Guy BAR-OZ, Jacqueline S. MEIER et al., "The Emergence of Animal Management ...".

49 Daniel HELMER, "Révision de la faune de Cafer Höyük (Malatya, Turquie) : apports des méthodes de l'analyse des mélanges et de l'analyse de Kernel à la mise en évidence de la domestication", in Emmanuelle VILA, Lionel GOURICHON, Alice M. CHOYKE et al. (eds), *Archaeozoology of the Southwest ...*, pp. 169-95; Daniel HELMER, Lionel GOURICHON, "Premières données sur les modalités de subsistance à Tell Aswad ...".

50 Joris PETERS, Angela von den DRIESCH, Daniel HELMER, "The Upper Euphrates-Tigris Basin ...".

51 At both sites *Capra* predominates; see Amaia ARRANZ-OTAEGUI, José Antonio LÓPEZ-SÁEZ, José Luis ARAUS et al., "Landscape Transformations at the Dawn of Agriculture in Southern Syria (10.7-9.9 Ka Cal. BP): Plant-Specific Responses to the Impact of Human Activities and Climate Change", *Quaternary Science Reviews*, vol. 158 (2017), pp. 145-63.

52 Pierre DUCOS, "Some remarks about *Ovis*, *Capra* and *Gazella* remains from two PPNB sites from Damascus, Syria, Tell Aswad and Ghoraife", in Hijlke BUITENHUIS, Annake T. CLASON (eds), *Proceedings of the Archaeozoology of the Near East and Adjacent Areas* (Leiden, 1993), pp. 37-45; Daniel HELMER, Lionel GOURICHON, "Premières données sur les modalités de subsistance à Tell Aswad ...".

than 70% and sometimes up to 98% of the ungulate remains.⁵³ On the Upper Euphrates in the NL, the MPPNB sites of Mezraa-Teleilat, Abu Hureyra and Tell Halula are located far from the natural habitat of wild goats (bezoar and/or ibex), offering strong evidence for the domestic status of the animals found there. Moreover, at Tell Halula at this time there is evidence for a selective cull of immature animals and size reduction in goats.⁵⁴

Biometric analysis of *Capra* remains in several SL sites to the south of the Damascus Basin shows a gradual size reduction by the end of the MPPNB,⁵⁵ a change in horn morphology,⁵⁶ and bias in mortality profiles that reflect a focus on young animals as seen at Beidha⁵⁷ and Abu Ghosh (fig. 4). However, at other SL sites such as Kfar Hahoresh and Yiftah'el, although the MPPNB *Capra* exhibit a slight reduction in body size, a shift in their age profile is only evident by the LPPNB/PPNC.⁵⁸ Similarly in 'Ain Ghazal, body size and age profiles only conform to that of domestic animals by the LPPNB.⁵⁹ The very high frequencies of *Capra* in the SL during the MPPNB, in areas close to the natural habitat of wild *C. aegagrus* populations, has raised the question of autochthonous domestication of local animals. This possibility was first suggested by Horwitz on the basis of archaeozoological findings,⁶⁰ and has more recently been borne out by the palaeogenetic data that indicate a local *Capra* lineage.⁶¹

The domestication process of *Ovis* is fairly easy to follow. Figure 5 illustrates the progressive body-size decrease of *Ovis* populations from the PPNA to the MPPNB in the NL. This is first observed in the course of the EPPNB at Nevalı Çori⁶² suggesting that domestic sheep were probably present. They are also attested in layers preceding 7800 BC at the NL site of Akarçay Tepe on the

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- 53 Tamar DAYAN, Eitan TCHERNOV, Ofer BAR-YOSEF et al., "Animal Exploitation in Ujrat El-Mehed, a Neolithic Site in Southern Sinai", *Paléorient*, vol. 12, no. 2 (1986), pp. 105-16; Liora K. HORWITZ, Eitan TCHERNOV, Pierre DUCOS et al., "Animal domestication in the Southern Levant", *Paléorient*, vol. 25, no. 2 (1999), pp. 63-80.
- 54 Joris PETERS, Daniel HELMER, Angela von den DRIESCH et al., "Early Animal Husbandry in the Northern Levant", *Paléorient*, vol. 25, no. 2 (1999), pp. 27-47.
- 55 Natalie D. MUNRO, Guy BAR-OZ, Jacqueline S. MEIER et al., "The Emergence of Animal Management in the Southern Levant ...".
- 56 Juliet CLUTTON-BROCK, "The Primary Food Animals of the Jericho Tell from the Proto-Neolithic to the Byzantine Period", *Levant*, vol. 3, no. 1 (1971), pp. 41-55; Cheryl MAKAREWICZ, "Bridgehead to the Badia ...".
- 57 Bill FINLAYSON, Cheryl MAKAREWICZ, "The Neolithic of Southern Jordan", in Yehuda ENZEL, Ofer BAR-YOSEF (eds), *Quaternary Environments and Humans in the Levant* (Cambridge, 2017), pp. 743-52.
- 58 Pierre DUCOS, Liora K. HORWITZ, "The Pre-Pottery Neolithic B Fauna from the Lechevalier Excavations at Abu Ghosh", in Hamoudi KHALAILY, Ofer MARDER (eds), *The Neolithic Site of Abu Ghosh. The 1995 Excavations* (Jerusalem, 2003), pp. 103-19.
- 59 Cheryl MAKAREWICZ, "Bridgehead to the Badia ...".
- 60 Liora K. HORWITZ, "A Reassessment of Caprovine Domestication ..."; Liora K. HORWITZ, "Temporal and Spatial Variation ...".
- 61 Kevin G. DALY, Pierpaolo MAISANO DELSER, Victoria E. MULLIN et al., "Ancient Goat Genomes Reveal Mosaic Domestication in the Fertile Crescent", *Science*, vol. 361, no. 6397 (2018), pp. 85-88.
- 62 Joris PETERS, Angela von den DRIESCH, Daniel HELMER, "The Upper Euphrates-Tigris Basin: Cradle of Agro-Pastoralism?", in Jean-Denis VIGNE, Joris PETERS, Daniel HELMER (eds), *The First Steps of Animal Domestication: New Archaeozoological Approaches* (Oxford, 2005), pp. 41-48.

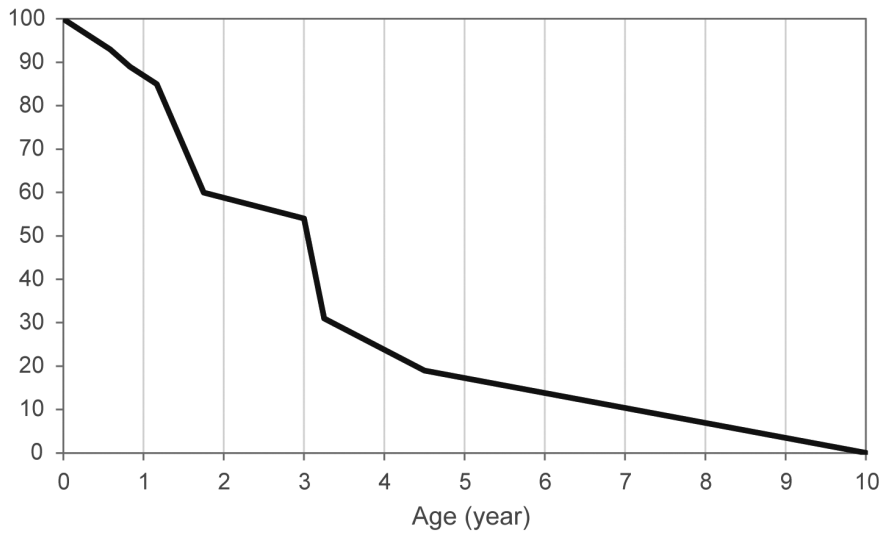


Figure 4. Survivorship curve for *Capra* at Abu Ghosh (based on Ducos and Horwitz 2003: table 11.5).

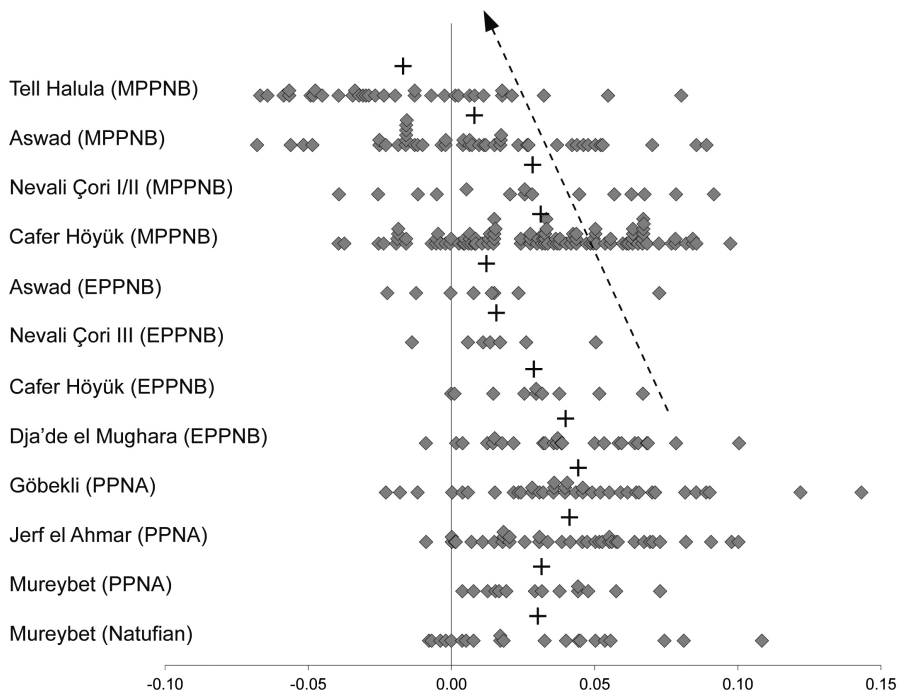


Figure 5. Distribution of LSI biometric data of *Ovis* in the Near East from the PPNA to the late Middle PPNB (based in part on Helmer and Gourichon 2008). The crosses correspond to the mean values and the arrow shows the progressive size reduction by the Early PPNB.

Euphrates.⁶³ *Ovis* frequencies in the NL begin to increase in the MPPNB and peak in the LPPNB,⁶⁴ although there are some exceptions, as at the site of Tell Halula, where ~~they~~ first appear only in the LPPN.⁶⁵ In the SL, domestic sheep remains are apparently absent in the EPPNB except at Tell Aswad in the oasis of Damascus.⁶⁶ The earliest domestic *Ovis* in sites further to the south occur in the MPPNB, at sites like 'Ain Ghazal and Basta.⁶⁷ Notably, for this species in the SL we lack evidence for a diachronic trajectory in size diminution, change in age and sex ratios, as well as morphology. Coupled with the absence of domestic sheep remains in all except one EPPNB site (Tell Aswad) and their paucity in the MPPNB, the latter represented already by quite small-sized animals of a “domestic phenotype”, it seems feasible to uphold the initial proposal by Horwitz and Ducos for the physical introduction of domestic sheep into the SL from the north.⁶⁸

By the LPPNB, throughout the Levant, there is unequivocal evidence for management of mixed herds comprising both domestic goats and sheep. It has been suggested that they served as sources of wealth by this time,⁶⁹ and were primarily exploited for meat, with limited evidence for secondary product exploitation (certainly milk). ~~The LPPNB and subsequent periods~~ are characterized by enormous intraregional variation and complexity in herd composition and management strategies, although production for meat seems to predominate.

Cattle: For cattle, the data show a large disparity in relative frequencies according to time periods with generally low numbers, even of hunted animals (aurochs) in the PPNA (fig. 6). Despite this, it is possible to distinguish groups of sites with high frequencies (30-50%) as in the MPPNB of the Euphrates Valley (NL),

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- 63 Maria SAÑA SEGUÍ, Carlos TORNERO, “Consumption of Animal Resources at the Sites of Akarçay Tepe and Tell Halula (Middle Euphrates Valley, 8th-6th Millennia Cal. BC)”, in Emmanuelle VILA, Lionel GOURICHON, Alice M. CHOYKE et al. (eds), *Archaeozoology of the Southwest ...*, pp. 153-67.
- 64 Joris PETERS, Daniel HELMER, Angela von den DRIESCH et al., “Early Animal Husbandry in the Northern Levant ...”; Gülçin ILGEZDI, “The Domestication Process in Southeastern Turkey: The Evidence of Mezraa-Teleilat”, PhD thesis (Eberhard-Karls-Universität Tübingen, 2008).
- 65 Maria SAÑA SEGUÍ, Carlos TORNERO, “Use of Animal Fibres during the Neolithisation in the Middle Euphrates Valley (Syria): An Archaeozoological Approach”, *Paléorient*, vol. 38, no. 1 (2012), pp. 79-91.
- 66 Pierre DUCOS, “Proto-élevage et élevage au Levant Sud au VII^e Millénaire B.C. : les données de la Damascène”, *Paléorient*, vol. 19, no. 1 (1993), pp. 153-73; Daniel HELMER, Lionel GOURICHON, “Premières données sur les modalités de subsistance à Tell Aswad ...”; Liora K. HORWITZ, Eitan TCHERNOV, Pierre DUCOS et al., “Animal domestication in the Southern Levant ...”.
- 67 Angela von den DRIESCH, Ursula WODTKE, “The Fauna of 'Ain Ghazal, a Major PPN and Early PN Settlement in Central Jordan”, in Hans Georg GEBEL, Zeidan KAFABI, Gary O. ROLLEFSON (eds), *The Prehistory of Jordan II: Perspectives from 1997* (Berlin, 1997), pp. 511-56; Alexander WASSE, “Final Results of an Analysis of the Sheep and Goat Bones from Ain Ghazal, Jordan”, *Levant*, vol. 34, no. 1 (2002), pp. 59-82; Cornelia BECKER, “The Analysis of Mammalian Bones from Basta ...”; Cornelia BECKER, “On the Identification of Sheep and Goats: The Evidence from Basta”, in Hans Jörg NISSEN, Mujahed MUHESEN, Hans Georg K. GEBEL (eds), *Basta I ...*, pp. 219-310.
- 68 Liora K. HORWITZ, Pierre DUCOS, “An Investigation into the Origins of Domestic Sheep in the Southern Levant”, in Hijlke BUITENHUIS, Lázló BARTOSIEWICZ, Alice M. CHOYKE (eds), *Archaeozoology of the Near East III* (Groningen, 1998), pp. 80-94.
- 69 Bill FINLAYSON, Cheryl MAKAREWICZ, “The Neolithic of Southern Jordan ...”.

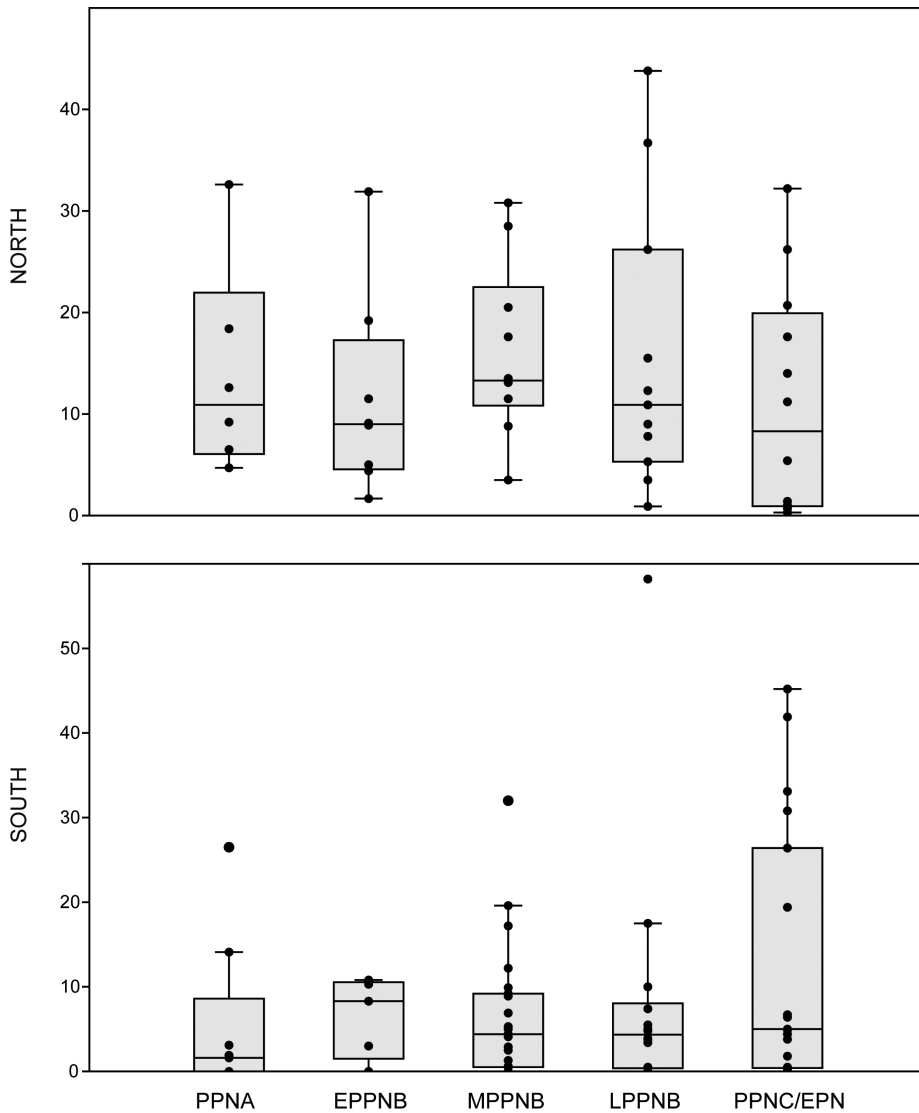


Figure 6. Relative frequencies of bovines (*Bos*) in the Neolithic sites of northern and southern Levant (based on the NISP of ungulate species).

and in the LPPNB–PPNC in the Galilee and on the SL coast, which correspond to more humid regions or those with permanent access to water.

Hitherto, the earliest claim for domestic cattle in the NL is from the EPPNB site of Dja'de.⁷⁰ This evidence is based not on size diminution, but on an apparent reduction in the extent of sexual dimorphism, which can be considered

⁷⁰ Daniel HELMER, Lionel GOURICHON, Hervé MONCHOT et al., “Identifying Early Domestic Cattle from Pre-Pottery Neolithic Sites on the Middle Euphrates Using Sexual Dimorphism”, in Jean-Denis VIGNE, Joris PETERS, Daniel HELMER (eds), *The First Steps of Animal Domestication ...*, pp. 86-95.

as a phenotypic change. Evidence for general size reduction in the NL is first found in the MPPNB site of Mezraa-Teleilat, though sample sizes are quite small. This trend of diminution continues in the more recent occupation phases (LPPNB/FPPNB) as well as in the nearby LPPNB site of Gritille Höyük.⁷¹ By the end of the MPPNB domestic cattle appear in the mid-Euphrates Valley at Tell Halula⁷² and perhaps slightly earlier in the MPPNB at Tell Aswad in the Damascus Basin. At the latter site, besides reduction in sexual dimorphism, skeletal modifications and pathologies are found that have been interpreted as evidence for their use as beasts of burden, thus, attesting to their management.⁷³ Further south in the SL, based on biometry and relative frequencies, domestic cattle are not clearly identified before the LPPNB/PPNC,⁷⁴ but are possibly present earlier, as evidenced by a slight size reduction documented at MPPNB Yiftah'el and LPPNB Basta, though there is no evidence for an associated shift in age or sex profiles.⁷⁵

A recent study of aDNA shows that domestic cattle initially derived from a restricted NL genetic source.⁷⁶ Outside this area, cattle gained heterogeneous input from diverse aurochsen lineages, including those specific to European and African cattle ancestors. The same study demonstrates a southern Levantine genome affinity with North African aurochs, distinct from the core Anatolia/Iran ancestral Near Eastern cluster – and so may indicate an autochthonous domestication event for cattle in the SL.

Pig: Regarding the pig, metrics of their bones and teeth often do not enable clear distinction of wild *versus* domestic forms impeding separation of wild boar from early domestic animals. As both were exploited for their meat and skins, they often exhibit similar cull patterns with a predominance of immature individuals. Thus, a unidirectional trend of size reduction coupled with morphological change, **are** of necessity the most rigorous characteristics for assessing domestication in pigs. As illustrated in figure 7, there are high frequencies of pig in some relative humid areas of the Levant, but they vary by period and show no clear chronological trend. The earliest proposed evidence for domestication

71 Gülçin ILGEZDI, “The Domestication Process in Southeastern Turkey: The Evidence of Mezraa-Teleilat ...”; Belinda H. MONAHAN, “The Organization of Domestication at Gritille, a Pre-Pottery Neolithic B Site in Southeastern Turkey”, PhD thesis (Northwestern University, Evanston, IL, 2000).

72 Maria SAÑA SEGUÍ, Carlos TORNERO, “Consumption of Animal Resources ...”.

73 Daniel HELMER, Lionel GOURICHON, “Premières données sur les modalités de subsistance à Tell Aswad ...”; Daniel HELMER, Emilie BLAISE, Lionel GOURICHON et al., “Using cattle for traction and transport during the Neolithic period. Contribution of the study of the first and second phalanges”, *Bulletin de la Société Préhistorique Française*, vol. 115 (2018), pp. 71-98.

74 Liora K. HORWITZ, Pierre DUCOS, “Counting Cattle: Trends in Neolithic *Bos* Frequencies from the Southern Levant”, *Revue de Paléobiologie*, vol. 10 (2005), pp. 209-24; Nimrod MAROM, Guy BAR-OZ, “The Prey Pathway ...”.

75 Lidar SAPIR-HEN, Tamar DAYAN, Hamoudi KHALAILY et al., “Human Hunting and Nascent Animal Management at Middle Pre-Pottery Neolithic Yiftah'el, Israel ...”; Cornelia BECKER, “The Analysis of Mammalian Bones from Basta ...”.

76 Marta Pereira VERDUGO, Victoria E. MULLIN, Amelie SCHEU et al., “Ancient Cattle Genomics, Origins, and Rapid Turnover in the Fertile Crescent”, *Science*, vol. 365 (2019), pp. 173-76.

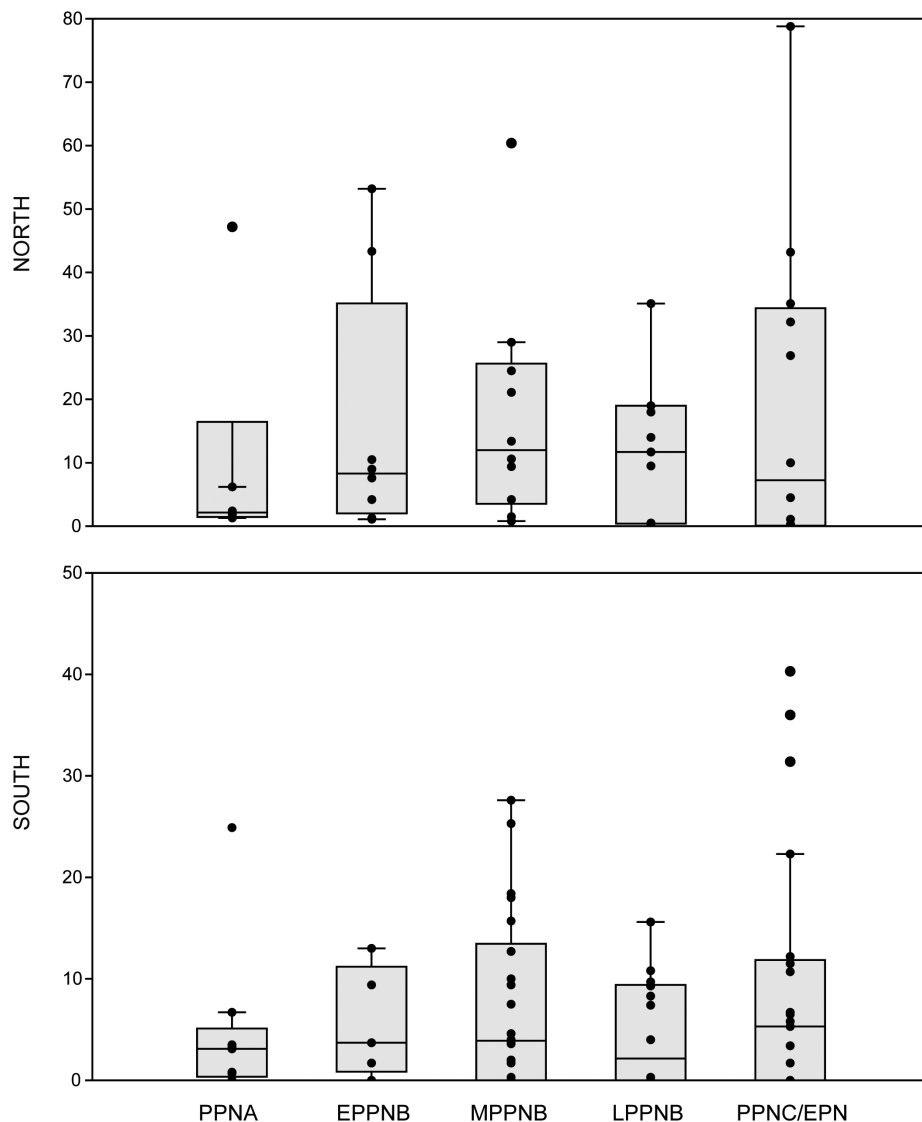


Figure 7. Relative frequencies of suids (*Sus*) in the Neolithic sites of northern and southern Levant (based on the NISP of ungulate species).

is found in the NL sites of Çayönü Tepesi and Nevalı Çori, where biometric evidence for size reduction and age profiles indicating harvesting of immature animals (as well as isotope analyses and hypoplasia scores) led researchers to suggest that pig domestication was initiated already in the EPPNB.⁷⁷ However,

⁷⁷ Joris PETERS, Angela von den DRIESCH, Daniel HELMER, “The Upper Euphrates-Tigris Basin ...”; Max PRICE, Hitomi HONGO, “The Archaeology of Pig Domestication in Eurasia”, *Journal of Archaeological Research*, vol. 28 (2020), pp. 557-615.

clear unidirectional size and shape changes at these and other sites in the NL (Gritille Höyük, Mezraa-Teleilat), as well as further south at Tell Halula, are only observed by the LPPNB.⁷⁸ In the SL, ~~in the MPPNB~~, pigs at sites such as Yiftah'el, show a size reduction compared to the preceding EPPNB at Motza,⁷⁹ but unidirectional size reduction only becomes widespread by the PPNC–PN where increased numbers of pigs are also associated with a high immature cull at several sites.⁸⁰ Clearly, our current understanding of pig domestication is imperfect and much about this process is unclear. This is illustrated by the inability of current aDNA ~~results~~ to elucidate whether pigs underwent separate and autochthonous domestication events in the northern and southern Levant respectively.

Northern-southern Levantine Neolithic interactions

The term “PPNB interaction sphere” has been used to describe the interconnection of Neolithic Levantine communities (perceived by some researchers as tribal) that were united by a common ideology, as well as by socioeconomic interests.⁸¹ This concept is based on the rich archaeological record for the period that documents connections in material culture between NL and SL throughout the Neolithic, although as noted in the introduction, radiocarbon dates denote an apparent lack of synchronicity between the regions. It is expressed in a time lag of some 300/400 years BP between them, with the earliest appearance of the Neolithic and its associated cultural attributes in the north (Euphrates/SE Anatolian region).⁸² Furthermore, from the EPPNB onwards, the directionality

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- 78 Gülçin ILGEZDI, “The Domestication Process in Southeastern Turkey ...”; Belinda H. MONAHAN, “The Organization of Domestication at Gritille, a Pre-Pottery Neolithic B Site in Southeastern Turkey ...”; Maria SANA SEGUÍ, Carlos TORNERO, “Consumption of animal resources at the sites Akarçay Tepe and Tell Halula ...”.
- 79 Natalie D. MUNRO, Guy BAR-OZ, Jacqueline S. MEIER et al., “The Emergence of Animal Management ...”.
- 80 Annat HABER, Tamar DAYAN, Nimrod GETZOV, “Pig Exploitation at Hagoshrim: A Prehistoric Site in the Southern Levant”, in Jean-Denis VIGNE, Joris PETERS, Daniel HELMER (eds), *First Steps of Animal Domestication ...*, pp. 80-85; Nimrod MAROM and Guy BAR-OZ, “The Prey Pathway ...”.
- 81 Ofer BAR-YOSEF, Anna BELFER-COHEN, “The Origins of Sedentism and Farming Communities in the Levant”, *Journal of World Prehistory*, vol. 3, no. 4 (1989), pp. 447-98; Ofer BAR-YOSEF, “From Sedentary Foragers to Village Hierarchies: The Emergence of Social Institutions”, in Walter G. RUNCIMAN (ed.), *The Origin of Human Social Institutions* (Oxford, 2001), pp. 1-138; Jacques CAUVIN, *The Birth of the Gods and the Origins of Agriculture* (Cambridge, 2000); Ian KUIJT, Nigel A. GORING-MORRIS, “Foraging, Farming, and Social Complex in the Pre-Pottery Neolithic ...”; for critique see Eleni ASOUTI, “Beyond the Pre-Pottery Neolithic B Interaction Sphere”, *Journal of World Prehistory*, vol. 20, no. 2 (2006), pp. 87-126; Ferran BORRELL, Miquel MOLIST, “Social Interaction at the End of the Pre-Pottery Neolithic B: An Inter-Site Analysis in the Euphrates Valley”, *Cambridge Archaeological Journal*, vol. 24, no. 2 (2014), pp. 215-32.
- 82 Olivier AURENCHE, Jacques CAUVIN, Marie-Claire CAUVIN et al., “Chronologie et Organisation de l’Espace dans le Proche-Orient de 12 000 à 5 600 avant J.-C.”, in Jacques CAUVIN, Paul SANLAVILLE (eds), *Préhistoire du Levant*, (Paris, 1981), pp. 571-601; A. Nigel GORING-MORRIS, Anna BELFER-COHEN, “Neolithization Processes in the Levant. The Outer Envelope”, *Current Anthropology*, vol. 52, no. suppl. 4 (2011), pp. S196-S208.

of the diffusion of technological knowledge and traditions has been established as running in a north-south unilateral direction, and then spreading eastwards and southwards into the desert margins.⁸³ One can track the southward diffusion of technocultural features such as rectilinear architecture, double-tanged projectile points, and bidirectional blade technology, followed by their local adaptation and/or appropriation in the south within autochthonous traditions.⁸⁴ Thus, despite north-south temporal heterogeneity in the Neolithization process, its dispersion did not follow a simple linear trend, but was associated with intraregional temporal and spatial variation.⁸⁵ This can be observed in bone artefact manufacture,⁸⁶ modes of subsistence as exemplified by regional variation,⁸⁷ and the appearance of regional lithic technocomplexes, as in Syria.⁸⁸ Interestingly, unequivocal examples of a reverse south-north diffusion are not documented, although it has been tentatively suggested that human skull removal follows such a gradient.⁸⁹ There is currently no consensus on whether the north-south contact entailed demic diffusion via physical movement of craftspeople, or solely a transmission of concepts and know-how; whether it was a constant diffusion or an exchange that occurred in pulses; and finally, whether this exchange entailed single cultural elements at disparate times or “Neolithic” packages.⁹⁰ It is patent however, that “Neolithization” was a long term process and that the changes it wrought were incremental and unidirectional.

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- 83 Phillip C. EDWARDS, “The Chronology and Dispersal of the Pre-Pottery Neolithic B Cultural Complex in the Levant”, *Paléorient*, vol. 42, no. 2 (2016), pp. 53-72; A. Nigel GORING-MORRIS, Anna BELFER-COHEN, “Neolithization Processes in the Levant ...”.
- 84 Avi GOPHER, “Central and Southern Levant PPN Cultural Sequences: Time-Space Systematics through Typological and Stylistic Approaches”, in Hans Georg GEBEL (ed.), *Neolithic Chipped Stone Industries of the Fertile Crescent* (Berlin, 1994), pp. 387-93; Ferran BORRELL, Hamoudi KHALAILY, “Reconstructing the Last Stages of Bidirectional Blade Technology in the Levant: North and South (Dis)Connections”, *Paléorient*, vol. 42, no. 2 (2016), pp. 73-95; Omry BARZILAI, *Social Complexity in the Southern Levantine PPNB as Reflected through Lithic Studies: The Bidirectional Blade Industries* (Oxford, 2010); Phillip EDWARDS, “The Chronology and Dispersal of the Pre-Pottery Neolithic B Cultural Complex in the Levant ...”.
- 85 Juan José IBÁÑEZ, Jesús GONZÁLEZ-URQUIJO, Luis Cesar TEIRA-MAYOLINI et al., “The Emergence of the Neolithic in the Near East: A Protracted and Multi-Regional Model”, *Quaternary International*, vol. 470 (2018), pp. 226-52.
- 86 Gaëlle LE DOSSEUR, “La Place de l’Industrie Osseuse dans la Néolithisation au Levant Sud”, *Paléorient*, vol. 34, no. 1 (2008), pp. 59-89.
- 87 A. Nigel GORING-MORRIS, Anna BELFER-COHEN, “Neolithization Processes in the Levant ...”; Bill FINLAYSON, Cheryl MAKAREWICZ, “Beyond the Jordan. Multiformalities of the Pre-Pottery Neolithic”, *Documenta Praehistorica*, vol. 47, Part B (2020), pp. 54-75.
- 88 For example, Marie-Claire CAUVIN, Danielle STORDEUR, *Les outillages lithiques et osseux de Mureybet. Fouilles Van Loon* (Paris, 1978); Ferran BORRELL, Eric BOËDA, Miquel MOLIST MONTAÑA et al., “New Evidence Concerning the Neolithisation Process of the Central Syrian Desert: The Neolithic Complex of Mamarrul Nasr”, *Paléorient*, vol. 37, no. 2 (2011), pp. 35-46.
- 89 Fanny BOCQUENTIN, Ergul KODAS, Anabel ORTIZ, “Headless but Still Eloquent! Acephalous Skeletons as Witnesses of Pre-Pottery Neolithic North-South Levant Connections and Disconnections”, *Paléorient*, vol. 42, no. 2 (2016), pp. 33-52.
- 90 See papers in Ianir MILEVSKI, Fanny BOCQUENTIN, Miquel MOLIST (eds), “Connections and Disconnections between the Northern and Southern Levant in the Late Prehistory and Protohistory (12th – mid-2nd mill, BC)”, *Paléorient*, vol. 42, no. 2 (2016), pp. 5-215.

As discussed in this paper, the chronological record for livestock domestication in the Levant follows a similar north-south direction to that accompanying changes in material culture. Its earliest appearance is the Euphrates/SE Anatolian region, based on archaeozoological criteria comprising changes in species frequencies and so archaeozoological assemblage composition, accompanied by shifts in age profiles, transformations in skeletal shape and size in the four ungulate taxa that were being targeted; sheep, goat, cattle and pigs. It is still premature to conclude whether this denotes a single nexus of animal domestication or multiple autochthonous events. ~~This, since~~, in the majority of sites studied in both the NL and SL, and aside from *Ovis* in the southern Levant, we can track in each region the full complement of representative changes within each taxon, beginning with a period of intensification in the manipulation of the targeted species which is manifest ~~in~~ their increased frequency in faunal assemblages. This is followed by evidence for more focused management discernible in a shift in age (and sex) profiles and finally in unidirectional shape and size change (diminution), although in some sites in the SL there is evidence for biometric change preceding shifts in herd demography.

While forms of game management already existed in the PPNA and the EPPNB, as documented by communal drive hunting of gazelles in the Euphrates valley,⁹¹ and the transportation of large wild mammals to Cyprus,⁹² the general trends that characterized the domestication process in the Levant are unique. They can be reconstructed from the “footprints” documented in this study and are summarized in the following paragraphs.

- In the NL, goat and sheep husbandry is clearly in progress since the EPPNB, with small-scale herding probably practised at the beginning while maintaining hunting of the wild progenitors (at Cafer Höyük, ~~Aşıklı Höyük~~). However, in the SL, the first signs only appear in the northernmost part of the SL by the early MPPNB (Tell Aswad) and by the LPPNB further to the south (Abu Ghosh, Jericho).
- For goats, both the archaeozoological and genetic data support evidence for independent, local domestication events in NL and SL respectively. Only domesticated sheep appear to have been physically introduced into the SL as originally proposed by Horwitz and Ducos although the timing is set slightly earlier than they initially proposed, by ca.8000 cal. BC.⁹³ Currently, this appears to have been a physical diffusion despite data attesting to the existence and hunting of wild sheep in the arid margins of the region.
- Cattle may have been managed since the EPPNB in the Euphrates Valley, but certainly by the MPPNB they were under cultural control. This seems to

91 Anthony LEGGE, Peter ROWLEY-CONWY, “Gazelle Killing in Stone Age Syria”, *Scientific American*, vol. 257, no. 2 (1987), pp. 88-95; Lionel GOURICHON, “Faune et Saisonnalité ...”.

92 Jean-Denis VIGNE, Antoine ZAZZO, Jean-François SALIÈGE et al., “Pre-Neolithic Wild Boar Management and Introduction to Cyprus More than 11,400 Years Ago”, *Proceedings of the National Academy of Sciences*, vol. 106, no. 38 (2009), pp. 16135-38; Jean-Denis VIGNE, Isabelle CARRÈRE, François BRIOIS et al., “The Early Process of Mammal Domestication in the Near East: New Evidence from the Pre-Neolithic and Pre-Pottery Neolithic in Cyprus”, *Current Anthropology*, vol. 52, no. S4 (2011), pp. S255-71.

93 Liora K. HORWITZ, Pierre DUCOS, “An Investigation into the Origins of Domestic Sheep ...”.

occur later (LPPNC/PN) in the SL, although evidence from the Damascus Basin and the northern Jordan Valley suggest a similar process was underway by the MPPNB. There is some indication for autochthonous domestication of this species in both the NL and SL.

- For pigs, the data are less robust and equivocal with some indications for an onset of domestication in the NL already in the EPPNB, but only by the LPPNB is there evidence to support its domestication as far south as Tell Halula. In the SL data supporting domestication of pigs is unequivocal only by the PPNC/PN. There is no genetic information for pigs regarding separate domestication events in the Levant and further research is needed.
- There was a delay in the timing of cattle and pig domestication in both the NL and SL relative to caprines. The reasons for this are unclear. Although there are well-defined behavioural and ecological similarities amongst the ungulate quartet selected for domestication, there are also important differences between them⁹⁴ that may account for this time lag, such as the ferocity and large body size of aurochs (the progenitor of cattle) or aggressiveness and strength of wild boar, implying that people may only have tackled these more “problematic” species after they had accrued sufficient experience with the relatively more docile caprines. Local ecological factors relating to the specific food and water requirements of cattle and pigs may also have influenced this process, as demonstrated by Conolly and colleagues in their analysis of the biogeographic patterning of cattle-rearing in Southwest Asia and Europe, or Price and Evin for pig domestication.⁹⁵
- There was a progressive, but significant, reduction in the quantity of mammalian game animals (as well as reptiles and birds) during the PPNB, denoting a narrowing of the anthropic dietary base. Starting in the PPNA and EPPNB when hunting was an important and predominant mode of subsistence, a marked reduction of game animals followed in the MPPNB and continued into the LPPNB. From the PPNC onwards, wild animals formed a negligible component of most archaeozoological assemblages. This process signifies the evolution of the Anthropocene, an epoch that is characterized by a gradual shift in faunal biomass from wild mammals to a reliance on domestic livestock.
- Notably, in both the NL and SL, there is evidence for considerable intraregional diversity between sites in the timing of the first appearance of domestic animals and their adoption into the local culture. This may relate to the local environmental settings of sites as well as their distance from the core Mediterranean phytogeographic zone where domestication appears earliest. This process is also associated with inter- and intraregional differences in

94 For example, Juliet CLUTON-BROCK, “The process of domestication ...”; Richard H. MEADOW, “Osteological Evidence for the Process ...”; Wolf HERRE, Manfred RÖHRS, *Haustiere – Zoologisch Gesehen ...*.

95 James CONOLLY, Katie MANNING, Sue COLLEDGE et al., “Species distribution modelling of ancient cattle from early Neolithic sites in SW Asia and Europe”, *The Holocene*, vol. 22 (2012), pp. 997-1010; Max D. PRICE, Allowen EVIN, “Long-term morphological changes ...”.

architecture, material culture, settlement density and type and is most marked in the desert margins to the east and south of the Mediterranean zone.

- The currently available data sets provide an excellent diachronic framework with which to track the progression of domestication during the Neolithic in the Levant and its dispersion outwards. For example, today we can better understand the relation between the processes occurring in the Levant and that evident in the Neolithic of northeast Africa where domestic cattle, sheep, and goats are found by the mid-sixth millennium BC.⁹⁶ According to recent genetic research, it appears that African goats have a marked contribution from the Levant, but with considerable admixture from other sources.⁹⁷ This admixture may be the result of an expansion of inter-regional trade networks and livestock movement that is also discernible within the Fertile Crescent in periods after the Neolithic. For cattle, a similar SL contribution is documented supporting their southwards movement via a process of demic diffusion into the continent.⁹⁸ ~~Corroborating the pattern of introduction is the lag time in their arrival~~ – with domesticated caprines present in northeast Africa before domesticated cattle.⁹⁹
- As outlined in this paper, the transition from hunting to husbandry was neither rapid nor homogenous across the Levant. Although some events may be separated by only a few centuries, the apparent variation offers a huge challenge for archaeologists trying to fully understand the processes on such a small timescale. We also have to deal with a mosaic of communities sharing a broad cultural background who are closely interconnected, but yet maintain their own traditions in terms of subsistence practices, probably related to the ecological conditions in their surroundings.

While it is evident that the current Levantine faunal complex has been molded by many historical events, the Neolithic was a watershed. In contrast to other parts of the world, the archaeozoological record of the Levant proves that this region did not undergo the global Quaternary Megafauna Extinction event¹⁰⁰ but experienced asynchrony in extinction rates of different taxa over time, events which climaxed during the Holocene.¹⁰¹ Coupled with the adop-

96 Veerle LINSEELE, “Early Stock Keeping in Northeastern Africa: Near Eastern Influences and Local Developments”, in Noriyuki SHIRAI (ed.), *Neolithisation of Northeastern Africa* (Berlin, 2013), pp. 97-108; Veerle LINSEELE, Simon J. HOLDAWAY, Willeke WENDRICH, “The Earliest Phase of Introduction of Southwest Asian Domesticated Animals into Africa. New Evidence from the Fayum Oasis in Egypt and Its Implications”, *Quaternary International*, vol. 412 (2016), pp. 11-21.

97 Kevin DALY, Pierpaolo MAISANO DELSER, Victoria E. MULLIN et al., “Ancient Goat Genomes Reveal Mosaic Domestication in the Fertile Crescent ...”.

98 Marta Pereira VERDUGO, Victoria E. MULLIN, Amelie SCHEU et al., “Ancient Cattle Genomics, Origins, and Rapid Turnover in the Fertile Crescent ...”.

99 Veerle LINSEELE, Simon J. HOLDAWAY, Willeke WENDRICH, “The Earliest Phase of Introduction of Southwest Asian Domesticated Animals into Africa ...”.

100 Anthony D. BARNOSKY, “Megafauna Biomass Tradeoff as a Driver of Quaternary and Future Extinctions ...”.

101 Guy BAR-OZ, Lior WEISSBROD, “The Kaleidoscope of Mammalian Faunas during the Terminal Pleistocene and Holocene in the Southern Levant”, in Yehuda ENZEL, Ofer BAR-YOSEF (eds), *Quaternary Environments and Humans ...*, pp. 363-68.

tion of domestic livestock in the early Holocene, the entire natural biosphere inhabited by Levantine communities was dramatically and irrevocably impacted at this time. The ecological upheavals associated with livestock domestication (compounded by cultivated plants) encompass among other changes, natural habitat destruction and fragmentation, expansion of cultivated and settled areas, competition over grazing zones and overgrazing. These factors set in motion the events that culminated in widespread faunal extinctions in the Levant, affecting all but one of the wild progenitors of domestic herd animals.¹⁰² A concomitant development was a changeover in faunal biomass associated with a drastic reduction in mammalian diversity that left only four domestic ungulate taxa prevailing.

Aided by people, livestock have expanded beyond their natural biogeographic range and conquered all habitats worldwide, even the most inhospitable. Moreover, compared to wild mammals, higher densities of domestic mammals can inhabit any area, even those with low carrying capacities. This trend has culminated in the so-called “Livestock Revolution” which typifies our current demand-driven economies that focus on the production and consumption of domestic animal products. Thus, the seeds of our impoverished natural world are to be found in the Levantine Neolithic.

¹⁰² The wild boar is still found throughout the Levant; wild sheep, wild bezoar goats and aurochs are not.